Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

The researchers muse that their device might ultimately be used to power robotic systems that essentially scavenge and "eat" metal from their environment to keep themselves powered up. The inverted relationship between computing performance and energy storage makes it difficult to keep tiny devices such as robots the size of insects powered up. Shrink the battery the power tails off too much so that a device might only function for a minute before running out of power, explains Pikul. A bigger battery does not solve the problem as it simply adds weight and bulk to what was meant to be a tiny device.

"Metal scavenging is especially beneficial for small robots and electronics, whose size and performance are severely limited by the low energies provided by microenergy storage technologies," the team writes. For the time being, the system is being developed to power lights for buildings in the developing world that are not on any electricity and to power long-lasting sensors in shipping containers. [Wang et al. ACS Energy Lett., 2020; 5 (3): 758 doi: 10.1021/acsenergylett.9b02661]

David Bradley

1369-7021/https://doi.org/10.1016/j.mattod.2020.05.009

The boron conspiracy

An international team is working towards a way to make high-quality crystalline monoisotopic hexagonal boron nitride (hBN) at atmospheric pressure. Their research could open up new ways to make devices based on the carbon allotrope graphene function even more effectively by making the known process of sandwiching a carbon monolayer between two protective layers of hBN work better. It could also open up new research into phenomena that were hinted at such as exotic effects like magic-angle superconductivity.

The hBN crystals used in most experiments have been grown by a team in Japan using a complex high-temperature and high-pressure process. Taniguchi and Watanabe provide their materials to the scientific community at no charge. "They provide hundreds of labs around the world with ultra-pure hBN at no charge. Without their contribution, a lot of what we are doing today would not be possible," says Christoph Stampfer of RWTH Aachen University, Germany, who is part of the team working on the new approach.

The rather successful and useful Japanese does have limitations in that the hBN that can be grown in this way forms crystals limited to about 100 micrometers. A scalable method is now needed if hBN is to become an industrially tenable material. A team led by James Edgar of Kansas State University in the USA has developed the process with which the collaborators have worked.

"I was very excited when Edgar proposed that we test the quality of his hBN", says Stampfer. "His growth method could be suitable for large-scale production". The new method is far indeed much simpler and less costly than previously used methods. "The hBN crystals we received were the largest I have ever seen, and they were all based either on isotopically pure boron-10 or boron-11" adds Jens Sonntag of Aachen. The team used confocal Raman spectroscopy to test the quality of the crystals. hBN graphene sandwiches were then shown to have equivalent performance to those made with the Japanese hBN.

"This is a clear indication of the extremely high quality of these hBN crystals," explains Stampfer. "This is great news for the whole graphene community, because it shows that it is, in principle, possible to produce high quality hBN on a large scale, bringing us one step closer to real applications based on high-performance graphene electronics and optoelectronics. Furthermore, the possibility of controlling the isotopic concentration of the crystals opens the door to experiments that were not possible before."

hBN could be an essential material for the integration of graphene devices into current technology. A scalable synthetic route to the material paves the way. [Sonntag et al., 2D Mater. 2020, doi: 10.1088/20531583/ab89e5]

David Bradley

1369-7021/https://doi.org/10.1016/j.mattod.2020.05.008

Shedding ultraviolet light on coronavirus

It is well-known now that many viruses, including the emergent coronavirus that has led to the Covid-19 pandemic are destroyed by exposure to sunlight. However, in many environments chemical disinfectants must be used to ensure hygiene and reduce the serious risk of transmission of this potentially lethal respiratory virus. Now, a US team is building ultraviolet LEDs that could be used in a handheld device to destroy the virus quickly and efficiently in the healthcare environment, care homes, shops and restaurants and elsewhere. Such a development, which obviously hinges on developments in materials science, could help in our efforts to take control of this and future pathogens.

The team from the University of California Santa Barbara and their colleagues discuss details of their work on UV LEDs that can decontaminate surfaces, and perhaps even the air around us and liquids, including water, and kill the SARS-CoV-2 virus.

"One major application is in medical situations – the disinfection of personal protective equipment, surfaces, floors," explains Christian Zollner. An effective UV disinfection system active against the new virus could allow so-called PPE, personal protective equipment, to be made safe where there is pressure for it to be reused because of supply limitations, for instance. The team has demonstrated that UV disinfection can sterilize to the 99.9% level within 30 s and has been shown to work in sterilizing the interior of unoccupied vehicles. This would have the obvious application of reducing the risk of infection for paramedics and ambulance drivers after transporting an infected patient.

"UV-C light in the 260–285 nm range most relevant for current disinfection technologies is also harmful to human skin, so for now it is mostly used in appli-

cations where no one is present at the time of disinfection," Zollner explains. It cannot be used to sanitize hands or other areas of the skin safely as it causes burns and can damage the eyes.

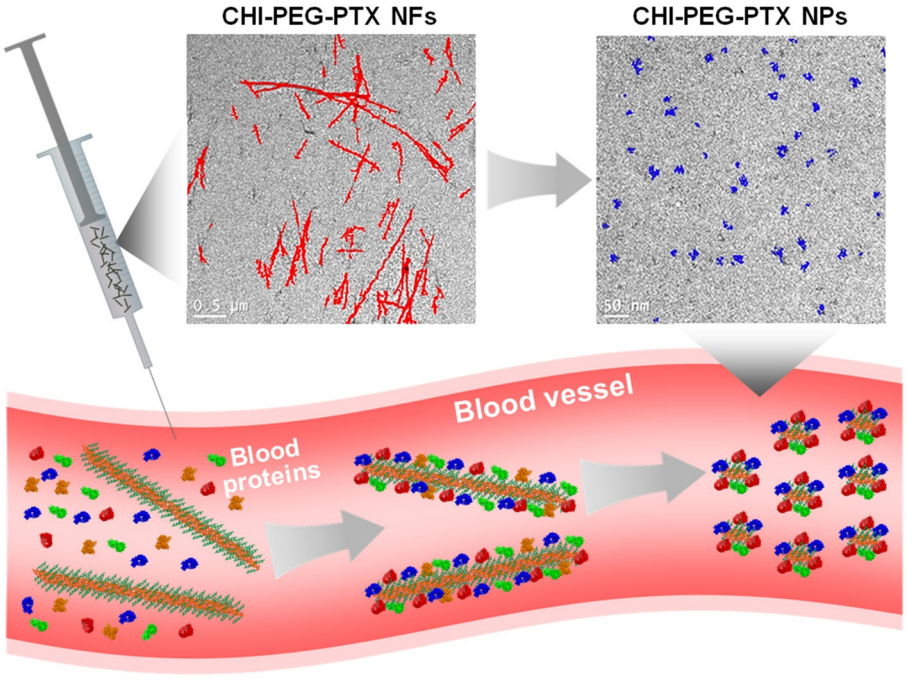
UV-C is commonly generated using mercury vapor lamps and much work needs to be done to bring UV LED technology to the same efficiency, cost, reliability, and lifetime. However, the team's work on fabricating high-quality deep-ultraviolet (UV-C) LEDs using film deposition of the semiconductor alloy aluminum gallium nitride (AlGaN) on to silicon carbide (SiC) avoids the use of sapphire substrate and could pave the way to a commercially viable UV-C LED. Silicon carbide suits deposition of the semiconductor better than sapphire. [Burhan et al. ACS Photonics, 2020; 7(3): 554 doi: 10.1021/acsphotonics.9b00600]

David Bradley

1369-7021/https://doi.org/10.1016/j.mattod.2020.05.007

Nanofibers split up in the body to deliver drugs

A drug-carrying nanofiber that splits into tiny nanoparticles once inside the body could offer a new strategy for anticancer therapy, according to researchers at the University of Washington [Mu et al., Mater. Today (2020), doi:10.1016/j.mattod.2020.03.005].



Nanoparticles can be loaded with therapeutic agents and injected into the body to deliver drugs safely and with greater efficacy, which is particularly desirable for cancer treatment, where side effects can be severe. An effective nanocarrier needs to be small – ideally less than 100 nm in diameter – even when loaded with its drug cargo to evade the immune system and must remain stable in the blood to allow it to circulate long enough to reach its target. Not only that, but the carrier must also be biocompatible.

Miqin Zhang and her team has come up with a clever to solution by creating a stable nanofiber with good drug loading capacity that splits into much smaller nanoparticles once inside the body. The nanofiber is synthesized from chitosan, a widely used biocompatible and biodegradable pharmaceutical ingredient, and polyethylene glycol (PEG) via a self-assembly process. In fiber form, the material is very stable and can be stored for months in the lab.

"We have introduced an innovative nanotherapeutic strategy by forming stable hydrophobic cancer drug (paclitaxel) conjugated nanofibers in solution. After entering the body, the drug-loaded nanofibers encounter serum proteins and rapidly fragment into ultrafine nanoparticles to deliver the drug," explains first author of the study, Qingxin Mu. "The nanofibers fragment into near-spherical nanoparticles within a minute," he adds.

Despite dissembling into smaller particles just 20 nm in diameter, the covalent bonds binding the drug to the chitosan-PEG fiber do not break in serum and the drug loading capacity is maintained.

"The nanoparticles travel through various biological barriers and release drug at the tumor site. Eventually, drug is metabolized by liver enzymes and cleared, with excipients degraded from the body," says Mu.

The team demonstrates this using paclitaxel, a clinically approved anticancer drug used to treat a range of solid tumors. In mouse models of aggressive drug-resistant breast cancer and melanoma, the new delivery system shows improved circulation times in the blood, low systemic toxicity, better localization of nanoparticles at the tumor, and enhanced inhibition of tumor growth and metastasis. The nanoparticles outperform the clinically used form of the drug, say the researchers, in terms of minimizing toxicity and the effectiveness of the treatment.

"The good stability, small nanoparticles size, and good drug loading render the approach suitable for hydrophobic drug delivery," says Mu.

The team now plans to explore whether the approach could work with other water-insoluble drugs and in different cancer models.

Cordelia Sealy

1369-7021/https://doi.org/10.1016/j.mattod.2020.05.006